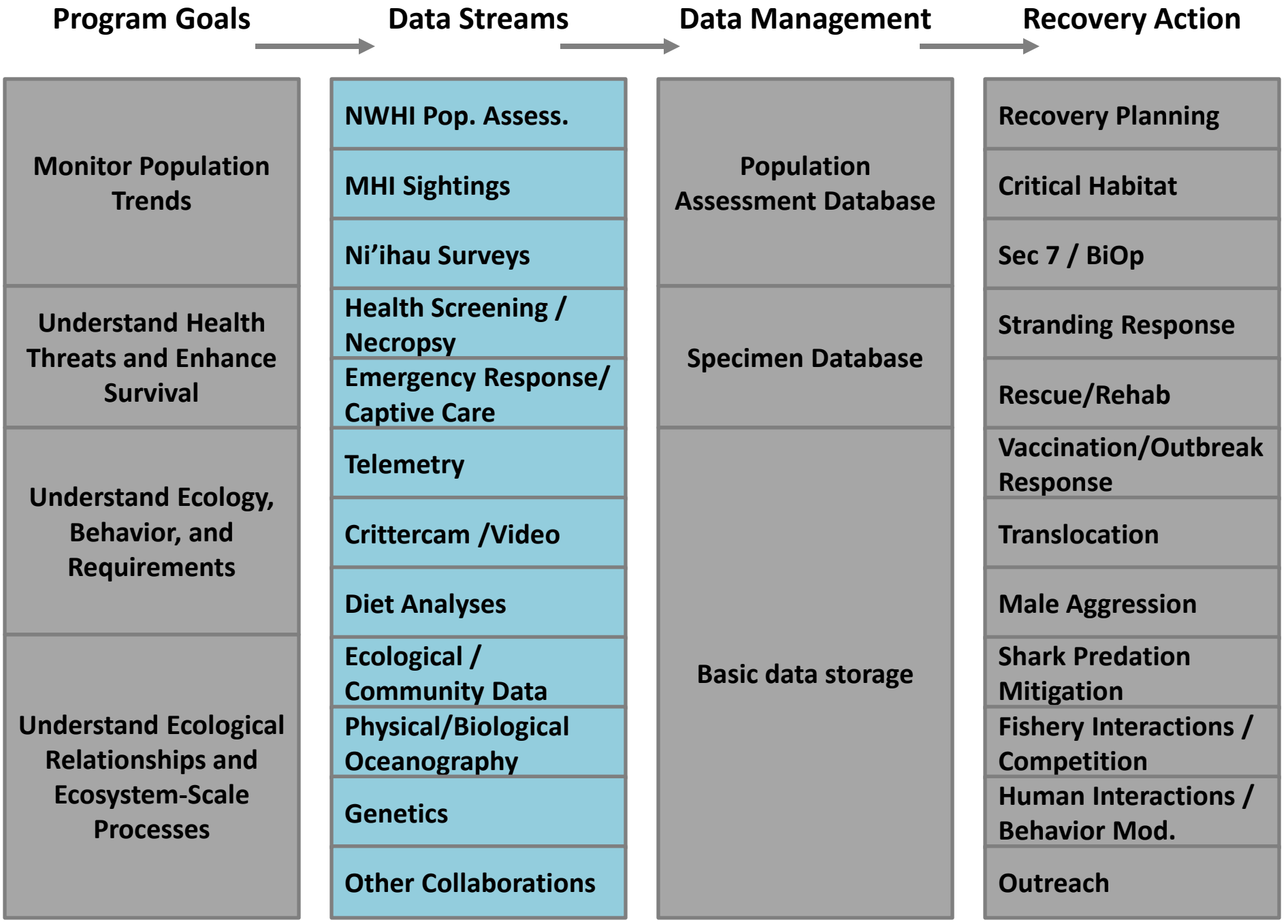
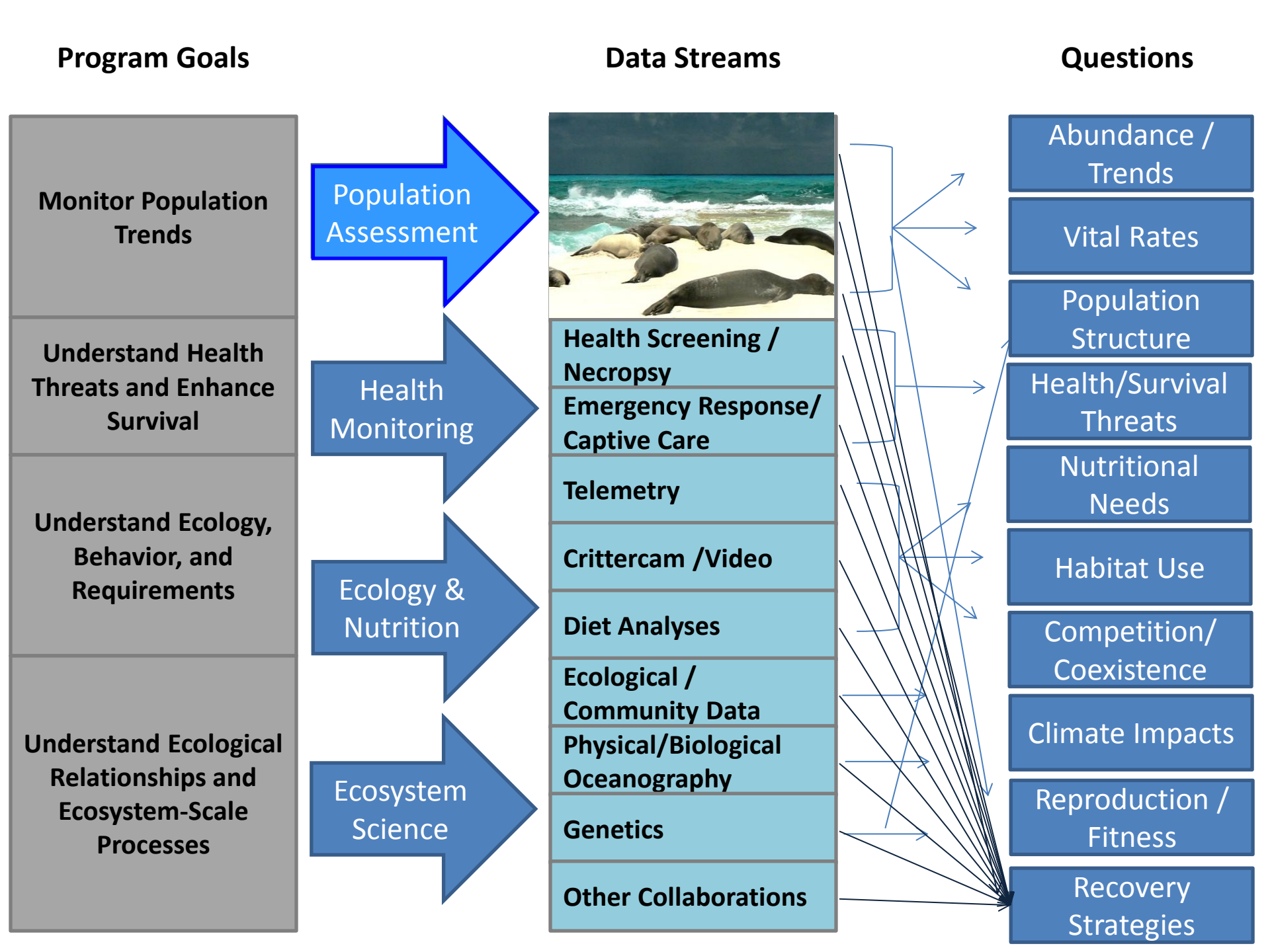
Hawaiian Monk Seal Research Program:
Data Streams Informing Monk Seal Research & Recovery

NOAA Fisheries Science Program Reviews
2015 Protected Species Science

Stacie J. Robinson

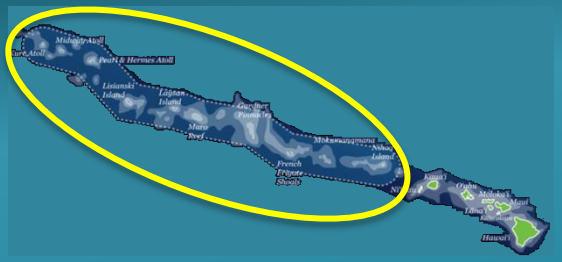

Program Goals
Data Streams
Data Management
Recovery Action
Monitor Population Trends
Understand Health Threats and Enhance Survival
Understand Ecology, Behavior, and Requirements
Understand Ecological Relationships and Ecosystem-Scale Processes
NWHI Pop. Assess.
MHI Sightings
Ni'ihau Surveys
Health Screening / Necropsy
Emergency Response/ Captive Care
Telemetry
Crittercam /Video
Diet Analyses
Ecological / Community Data
Physical/Biological Oceanography
Genetics
Other Collaborations
Population Assessment Database
Specimen Database
Basic data storage
Recovery Planning
Critical Habitat
Sec 7 / BiOp
Stranding Response
Rescue/Rehab
Vaccination/Outbreak Response
Translocation
Male Aggression
Shark Predation Mitigation
Fishery Interactions / Competition
Human Interactions / Behavior Mod.
Outreach


Program Goals
Data Streams
Questions
Monitor Population Trends
Understand Health Threats and Enhance Survival
Understand Ecology, Behavior, and Requirements
Understand Ecological Relationships and Ecosystem-Scale Processes
Population Assessment
Health Monitoring
Ecology & Nutrition
Ecosystem Science
Health Screening / Necropsy
Emergency Response/ Captive Care
Telemetry
Crittercam /Video
Diet Analyses
Ecological / Community Data
Physical/Biological Oceanography
Genetics
Other Collaborations
Abundance / Trends
Vital Rates
Population Structure
Health/Survival Threats
Nutritional Needs
Habitat Use
Competition/ Coexistence
Climate Impacts
Reproduction / Fitness
Recovery Strategies

Population Assessment

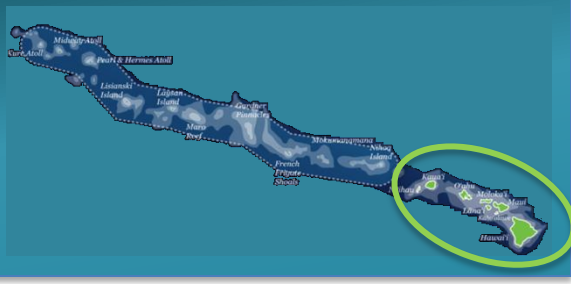
- We consistently monitor seal populations to assess vital rates and population trends.
- Study design varies geographically:
  - Decades of concentrated data from NWHI camps
  - Continuous reports from volunteers across MHI

NWHI Population Assessment



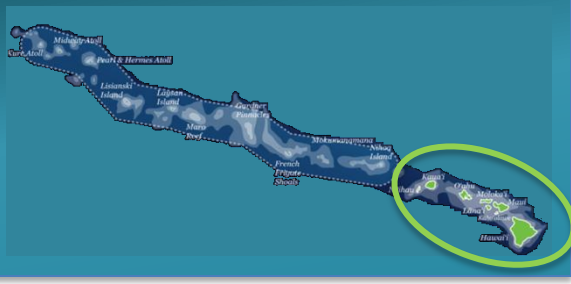
- Remote camps deployed
  - 5 NWHI seasonal camps
  - Short surveys at other sites
- Biologists conduct surveys
  - Tag animals & re-sight
  - Observe behavior & ecology
  - Perform survival enhancing interventions & monitor health
- Long term monitoring data informs population estimation and calculation of vital rates

MHI Sightings Network



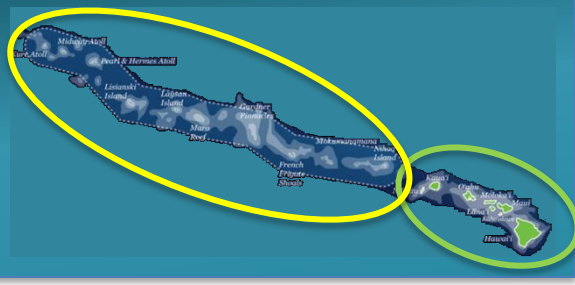
- Volunteer networks
- Public sighting reports
- Reports coded and transcribed into database
- Sighting data yields minimum occurrence counts

Niihau Surveys



- An important population center within the MHI
- Privately owned
- Surveyed with cooperation from Niihau Ranch and US NAVY
- Few survey days / year
- Abbreviated surveys yield beach counts as index of population

Seal Identification



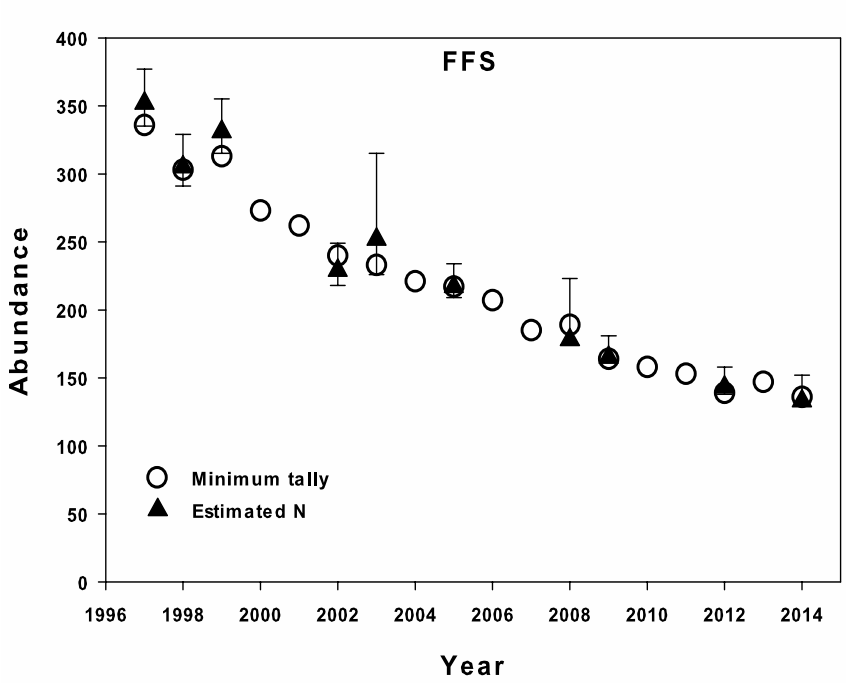
- Sighting and identifying seals forms the backbone of population data
- Natural bleaches
  - Photo ID database is important
  - Variable through life
- Temporary Bleaches
  - Seasonal
- Flipper tags
  - Most permanent

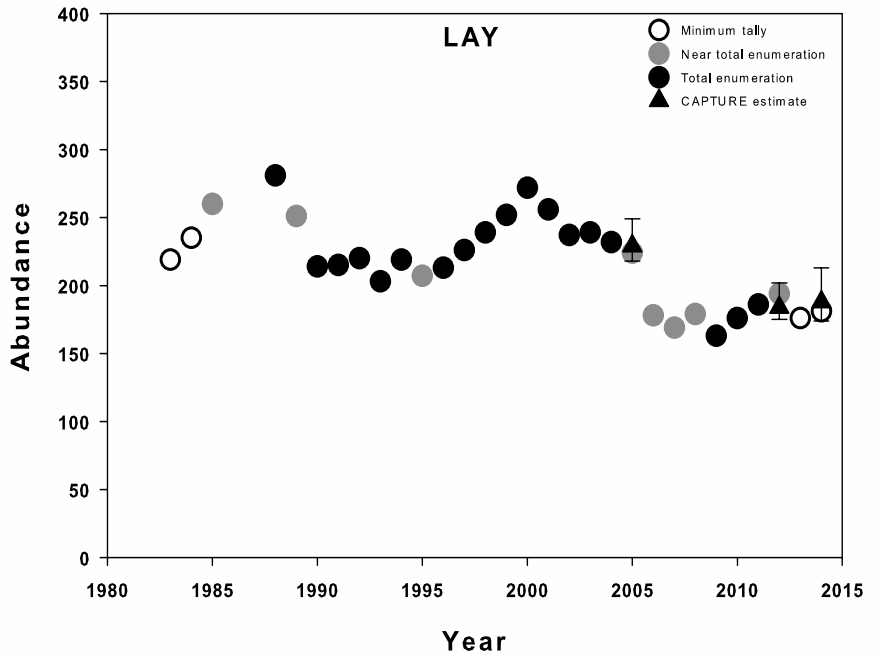
Harting et al. 2004

Population Data
Estimates & Trends

Northwest Hawaiian Islands

- Population estimated by mark-recapture models
- Trends vary across sites



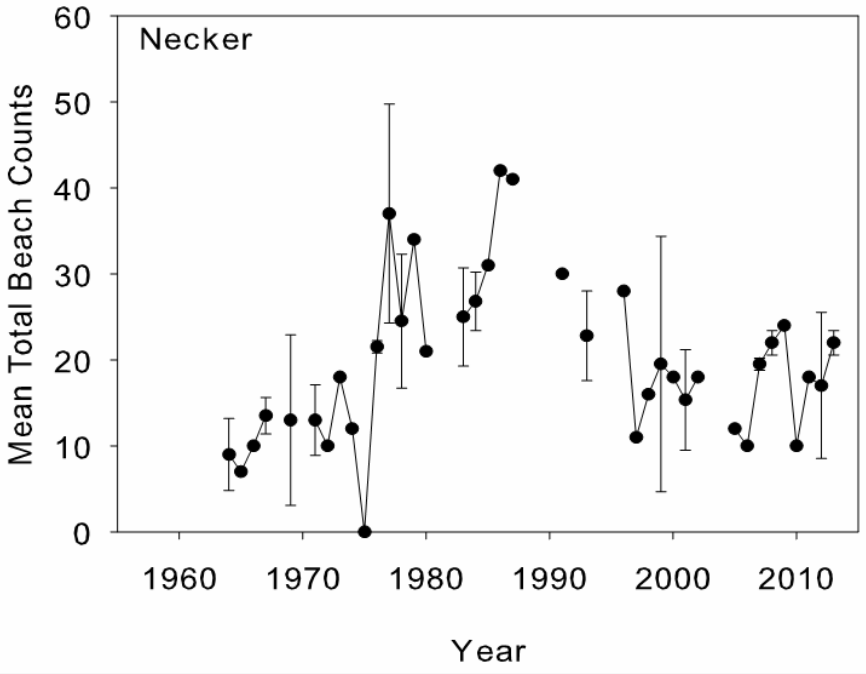


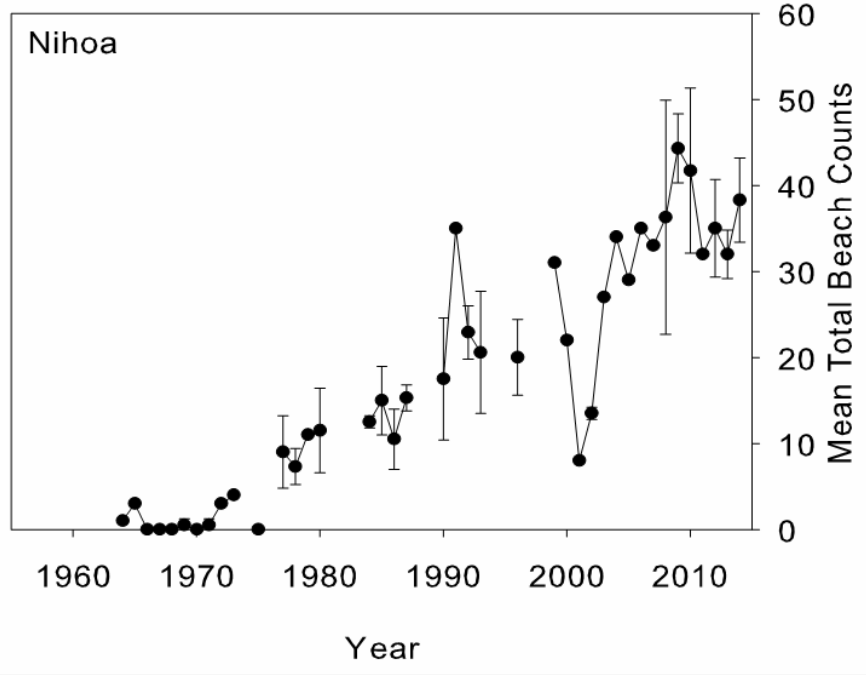
Baker et al. 2011
Hawaiian Monk Seal Research Program 2014a

Population Data
Estimates & Trends

Necker & Nihoa Islands

- Population estimated by beach count indexes
- Trends appear to be stabilizing in recent years



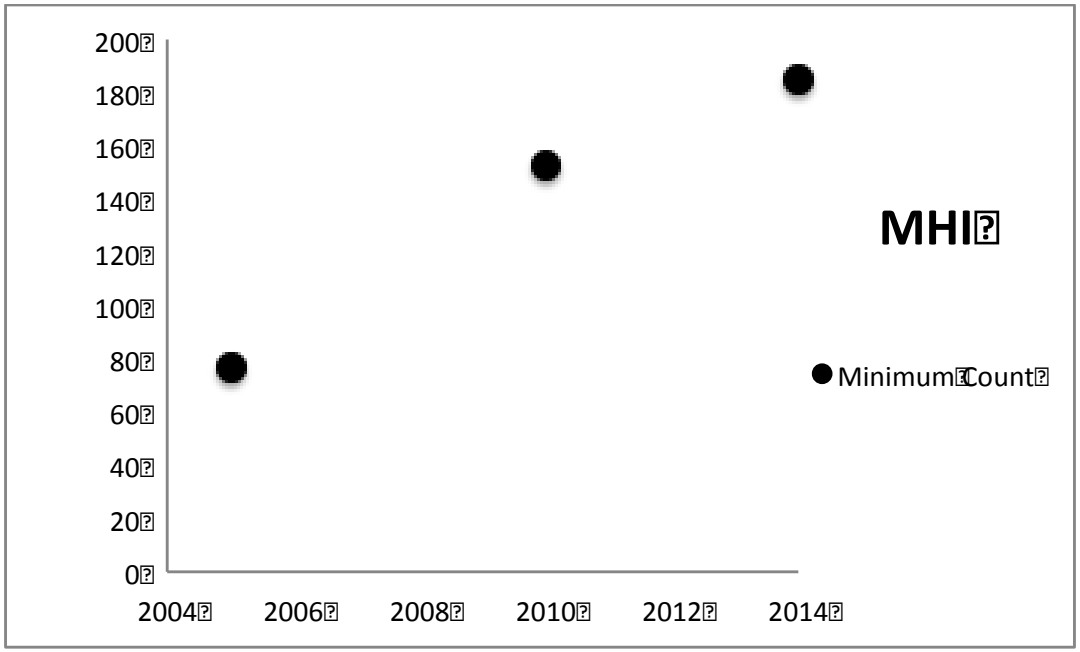


Hawaiian Monk Seal Research Program 2014b

Population Data
Estimates & Trends

Main Hawaiian Islands

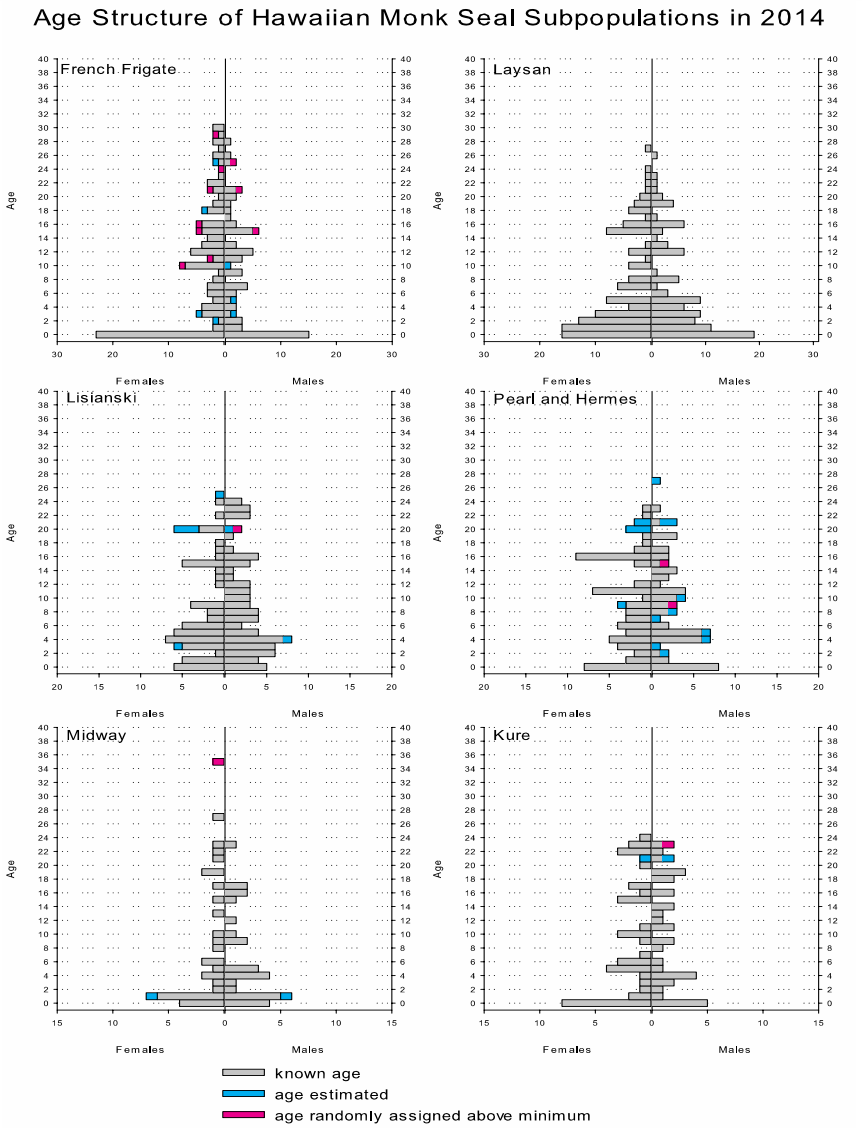
- Population estimated by minimum counts of identified individuals
- Trend appears positive in recent years



Baker et al. 2011
Hawaiian Monk Seal Research Program 2014a

Population Data
Vital Rates

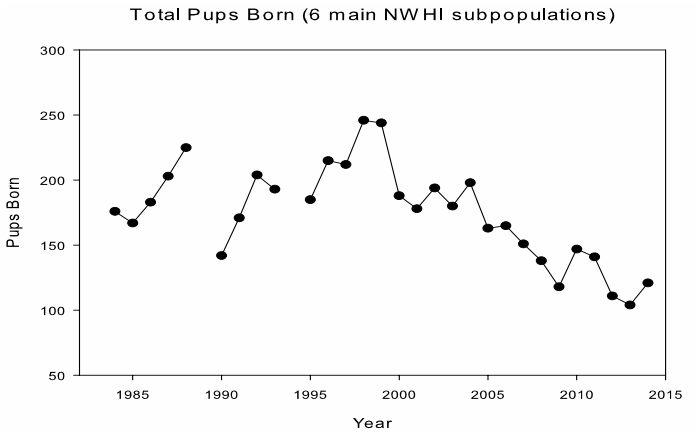
- Life tables are constructed from field observation data
- Stochastic simulation model is used to estimate population parameters and vital rates:
  - Population age/sex structure

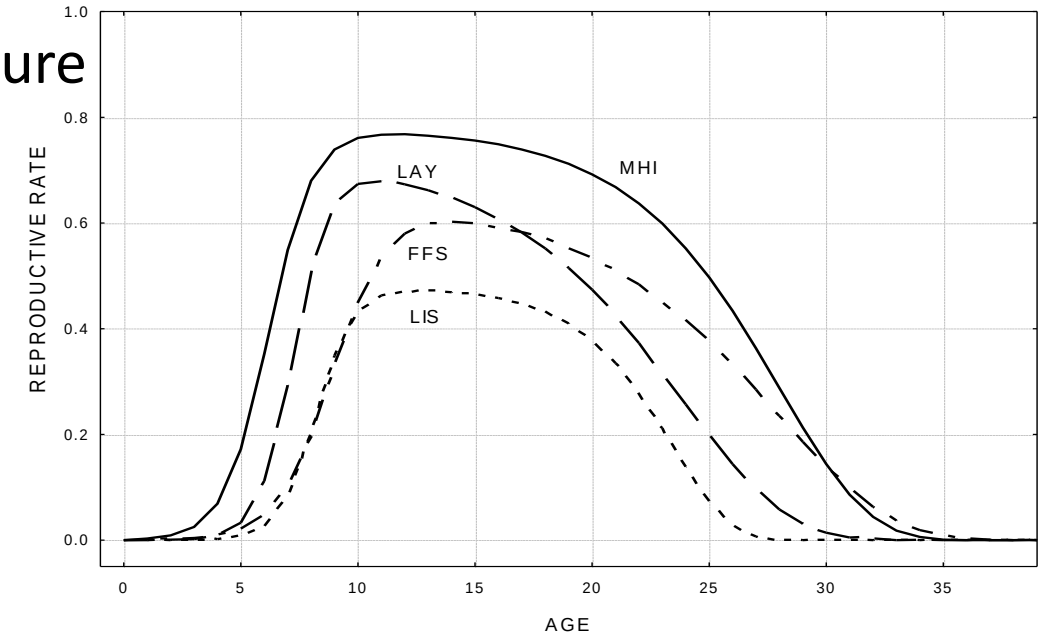


Harting 2002
Harting et al. 2007
Baker and Thompson 2007
National Marine Fisheries Service 2015

Population Data
Vital Rates

- Life tables are constructed from field observation data
- Stochastic simulation model is used to estimate population parameters and vital rates:
  - Population age/sex structure
  - Reproductive rates

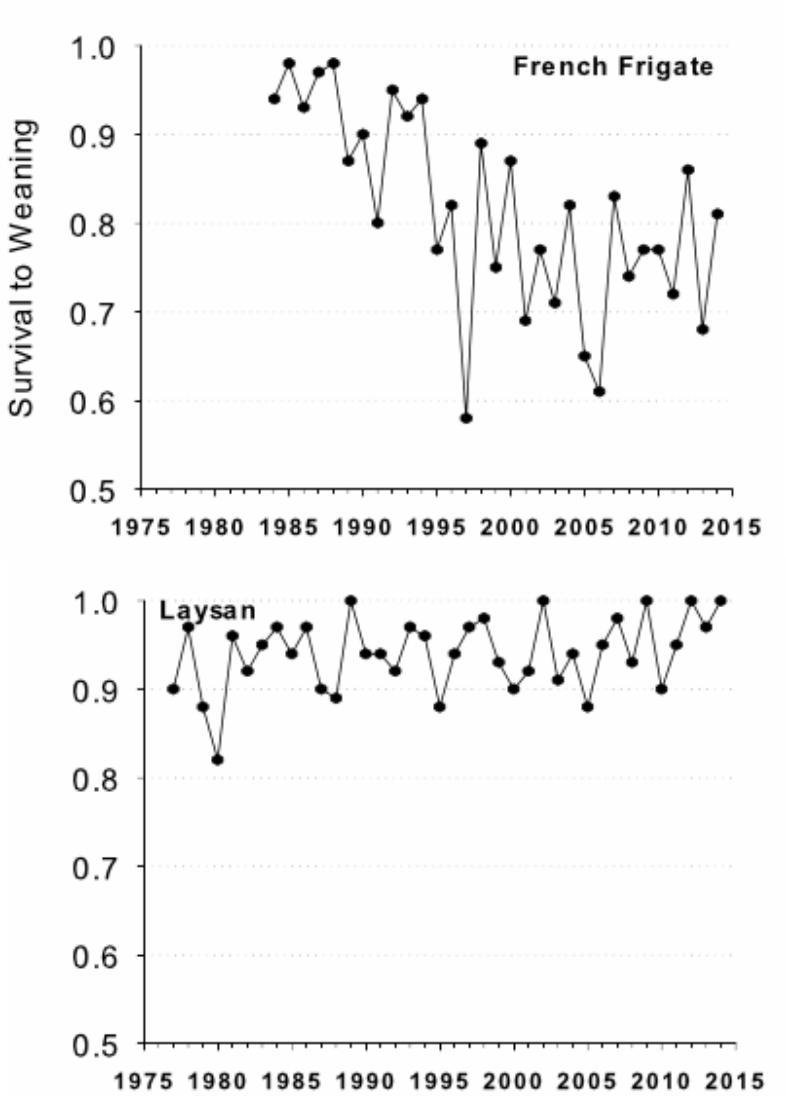




Harting 2002
Harting et al. 2007
Baker and Thompson 2007
National Marine Fisheries Service 2015

Population Data Estimates & Trends

- Life tables are constructed from field observation data
- Stochastic simulation model is used to estimate population parameters and vital rates:
  - Population age/sex structure
  - Reproductive rates
  - Survival rates



Harting 2002
Harting et al. 2007
Baker and Thompson 2007
National Marine Fisheries Service 2015

Population Data Estimates & Trends

- Life tables are constructed from field observation data
- Stochastic simulation model is used to estimate population parameters and vital rates:
  - Population age/sex structure
  - Reproductive rates
  - Survival rates
  - Population growth rates

Harting 2002
Harting et al. 2007
Baker and Thompson 2007
National Marine Fisheries Service 2015

Intrinsic growth rate (λ) for HMS subpopulations

FFS	LAY	LIS	PHR	MDY	KUR	MHI
0.950	1.000	0.973	0.973	0.978	0.913	1.033; 1.051

Successes & Challenges

NWHI

- Long running dataset
- Complete tracking of cohorts in sufficient field seasons
- Protocol adapted and data quality up-kept to maintain consistency over decades

MHI

- Data allows us to track localized recovery

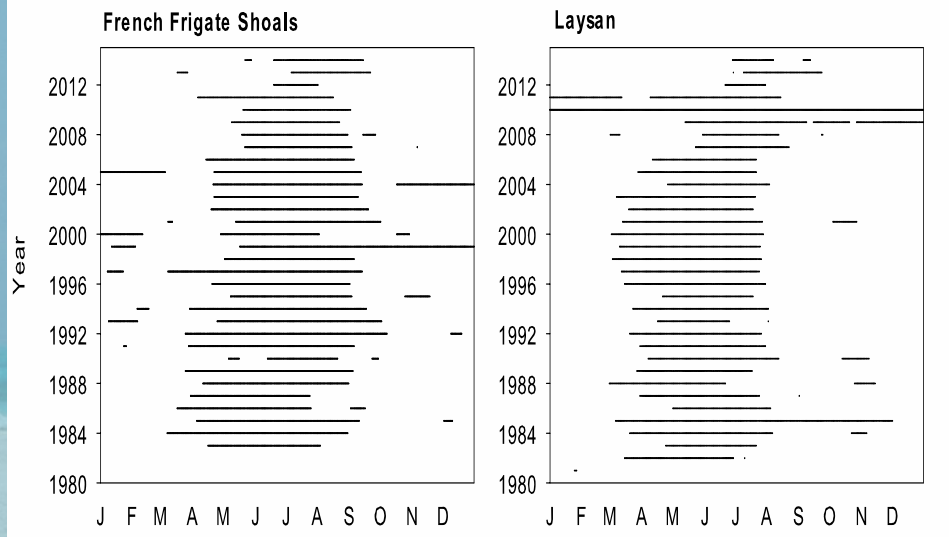
NWHI

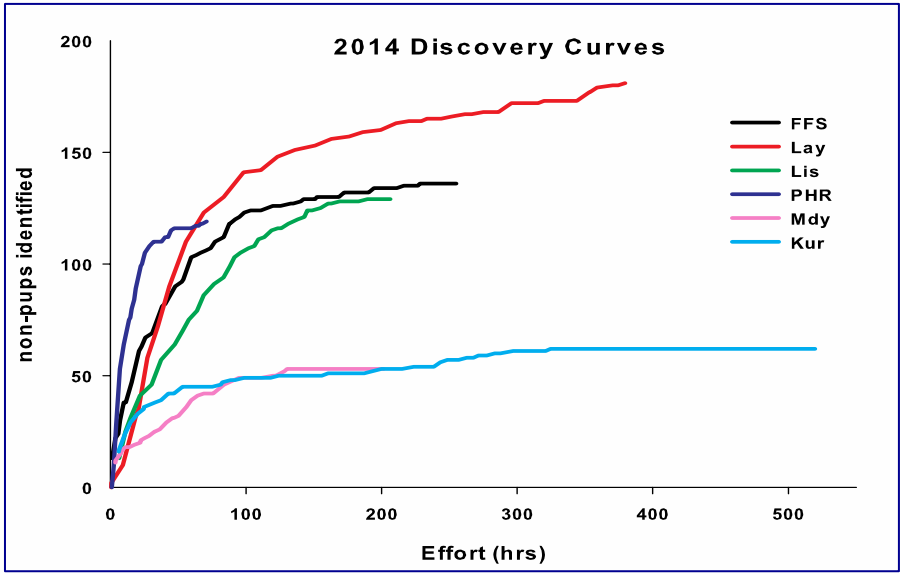
- Data tied to time in field
- Gaps in data = uncertainty in estimates

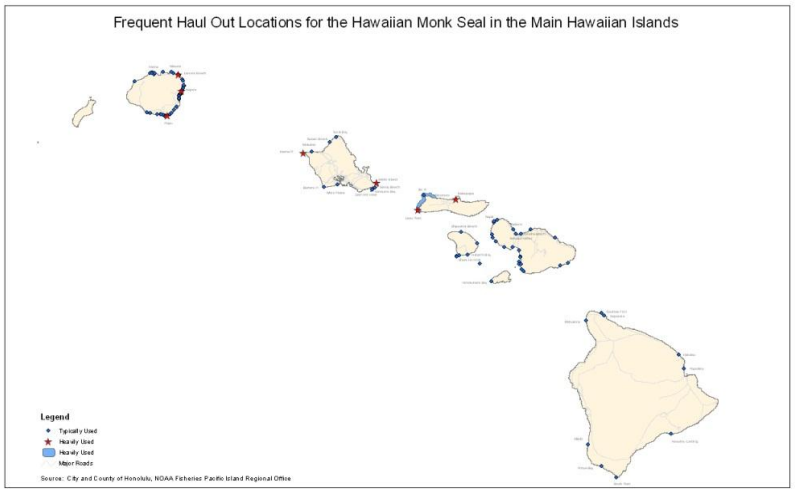
MHI

- Data limited by volunteer coverage
- Data biased by accessibility

Successes & Challenges







Program Goals

- Monitor Population Trends
- Understand Health Threats and Enhance Survival
- Understand Ecology, Behavior, and Requirements
- Understand Ecological Relationships and Ecosystem-Scale Processes

Data Streams

- Population Assessment
- Health Monitoring
- Ecology & Nutrition
- Ecosystem Science

- Telemetry
- Crittercam /Video
- Diet Analyses
- Ecological / Community Data
- Physical/Biological Oceanography
- Genetics
- Other Collaborations

Questions

- Abundance / Trends
- Vital Rates
- Population Structure
- Health/Survival Threats
- Nutritional Needs
- Habitat Use
- Competition/ Coexistence
- Climate Impacts
- Reproduction / Fitness

Health

We use intervention, emergency response, and health monitoring data to understand health threats and evaluate actions to improve both individual survival and population health.

Necropsy

- Necropsy samples
  - 2013: MHI 4, NWHI 6
  - 2014: MHI 12, NWHI 3
  - Gross pathology
  - Histopathology
  - Pathogen/disease screening
- Growing knowledge of mortality threats
  - Human interactions

    (hookings / trauma)
  - Diseases detection

    (toxoplasmosis, leptospirosis)

Health Monitoring

- Epidemiological sampling
  - Often opportunistic when animals are handled
  - ~40,000 samples ~ 80,000 aliquots
- Directed sampling / use of archived samples
  - NIST studies on contaminants and pathogens
  - Contaminant testing Lopez et al. 2012 and 2014
  - Ciguatoxin screening Ramsdell et al. ongoing
- Understand presence and prevalence

  Aguirre et al. 2007; Goldstein et al. 2006; Honnold et al. 2005; Littnan et al. 2006; Reif et al. 2004 and 2006
- Data helps evaluate health interventions

  Gobush et al. 2011 and 2014

Emergency Response

- Respond to emergencies as they occur
  - 2014 – 11 seals required treatment in MHI

- Response = intervention + data
  - Prevalence of survival threats
  - Individual seal risk factors (age/sex)
  - Local risk factors (human use/habitat conditions)
  - Opportunities to sample

Harting et al. 2014

Rehabilitation

- NOAA IRC - Honolulu
  - Short term post-intervention care
- TMMC Ke Kai Ola Monk Seal Hospital – Kona
  - Longer term rehabilitative & supportive care

- Captive care allows monitoring
- Captive animals provide data
  - Behavioral observation
  - Sampling in controlled environment
  - Opportunities for serial sampling

Successes & Challenges

- Protocols developed for safe capture, handling, veterinary care for sick/injured seals
- Collaborations with several labs with disease expertise
- New monk seal hospital opens potential to rehabilitate seals and learn about animal needs
- Data tracking of response activities demonstrates population-level impacts

- Ability to collect samples before degradation
- Ability to store/deliver quality samples from remote areas
- Test availability, accuracy, cost
- Improved reporting is essential for data and interventions

Program Goals

Monitor Population Trends

Understand Health Threats and Enhance Survival

Understand Ecology, Behavior, and Requirements

Understand Ecological Relationships and Ecosystem-Scale Processes

Population Assessment

Health Monitoring

Ecology & Nutrition

Ecosystem Science

Data Streams

Ecological / Community Data

Physical/Biological Oceanography

Genetics

Other Collaborations

Questions

Abundance / Trends

Vital Rates

Population Structure

Health/Survival Threats

Nutritional Needs

Habitat Use

Competition/ Coexistence

Climate Impacts

Reproduction / Fitness

Ecology & Nutrition

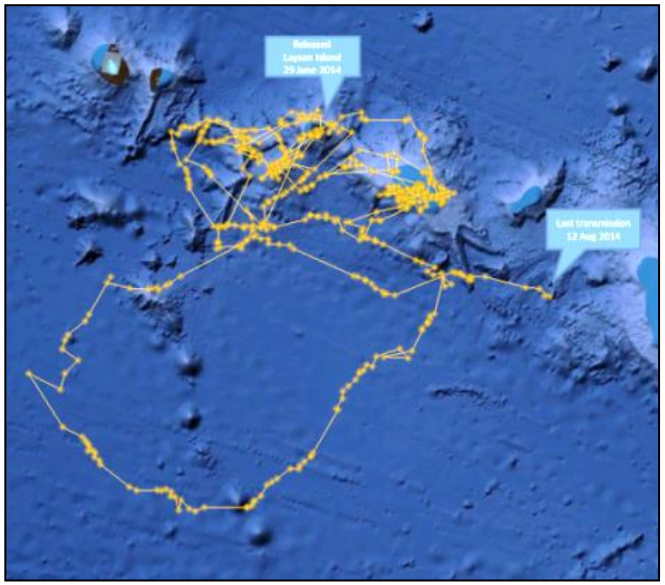
- We use of range of technologies to collect data to understand seal ecology, behavior, and resource needs.
- Studies have strategically involved animals of varied age/sex classes and locations.

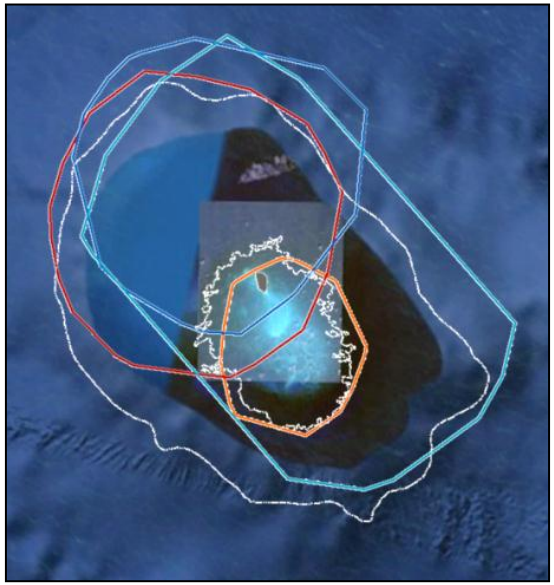
Instrumentation

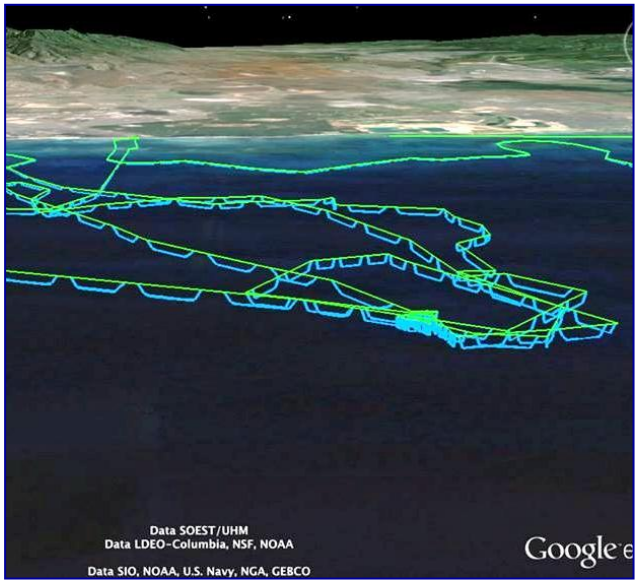
Tracking survival and impacts of translocation	**25 Translocated animals** **10 Rehabilitated & released animals**
Descriptive studies of foraging and movement ecology	**24 Satellite tags at FFS (adult M+F)** Parrish and Abernathy 2006 **147 Satellite tags throughout NWHI (all age/sex)** Stewart et al. 2006
Movement and foraging ecology related to habitat data	**15 Satellite tags at Lisianski (juveniles)** **29 Satellite tags at Nihoa (Translocations + Controls)** Norris 2013
Complex foraging behavior and interaction data	**50 Satellite tags** **40 Cell phone tags throughout MHI** **subsets with CritterCams & accelerometers** **60 CritterCams** Littnan et al. 2004; Moll et al. 2007; Parrish et al. 2005; Wilson et al. 2015 and ongoing

Telemetry

- Tracking animals to monitor survival and understand impacts of interventions
- Estimating space use to evaluate development of foraging behavior
- Using depth profiles to understand dive patterns and foraging behavior





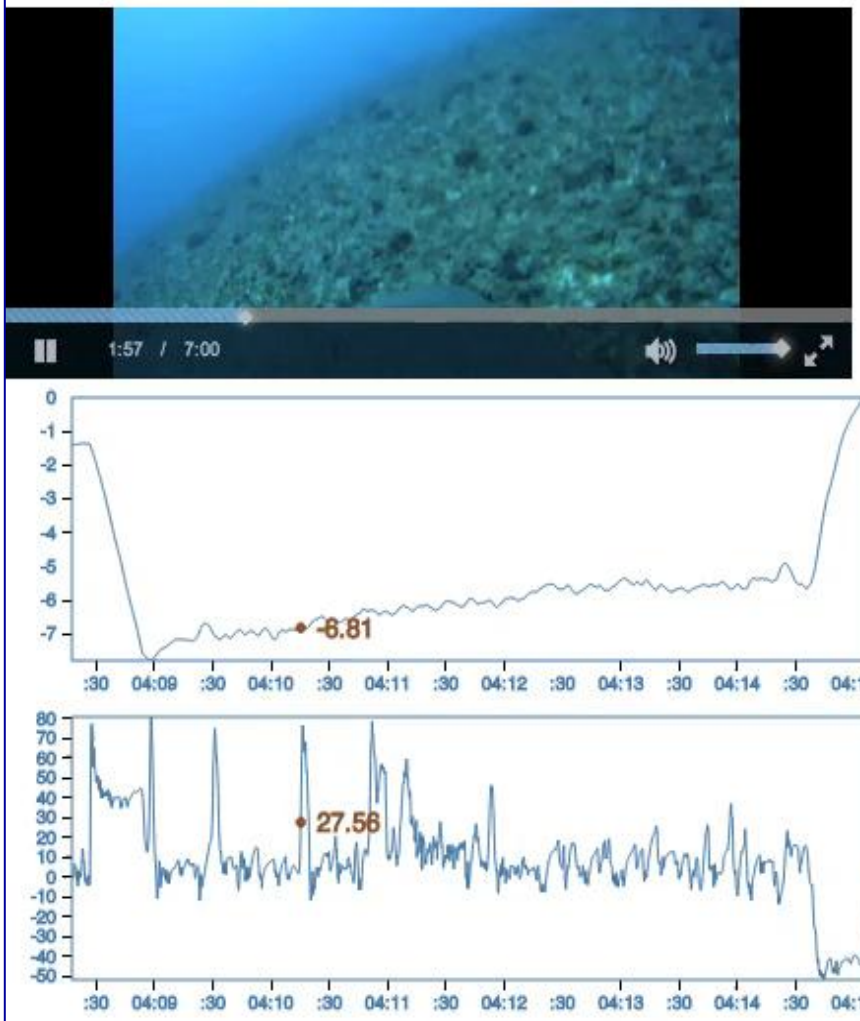


CritterCam / Video

- We document prey encountered, feeding rates, prey selection, and foraging methods
- We detect interactions with competing predators to inform ecological studies
- Videos provide an engaging outreach tool to help dispel myths about monk seal ecology

Instrumentation

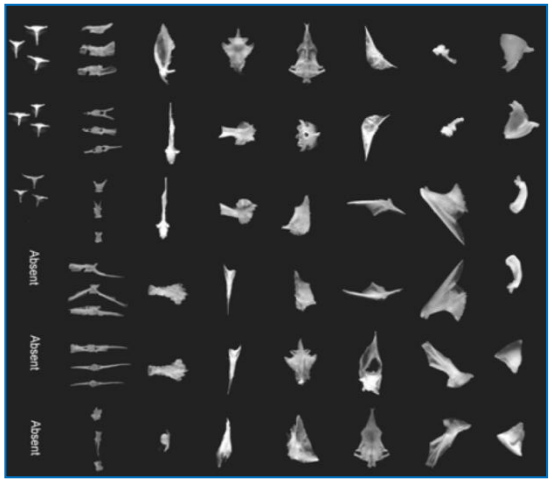
- Integration of data types across instruments gives a complex view of animal behavior and ecology
  - Link sensor readings to behaviors
  - Foraging behavior
  - Foraging areas/depths
  - Travel/movement pattern

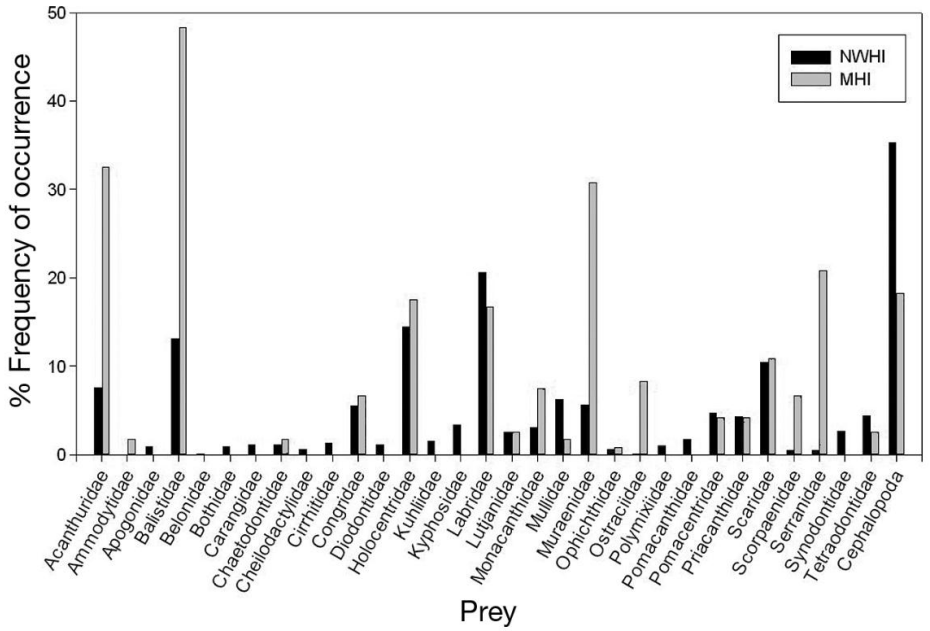


Wilson et al. ongoing

Diet Analysis

- Fecal/regurgitate prey remains ID
  - 120 samples
  - Weanling to adult
- Frequency of Occurrence describes diet
- Species Overlap identifies distinctions between NWHI and MHI diets

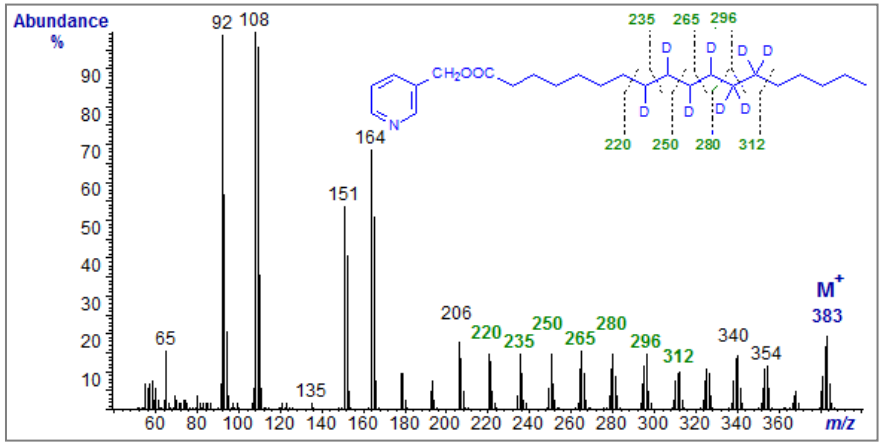


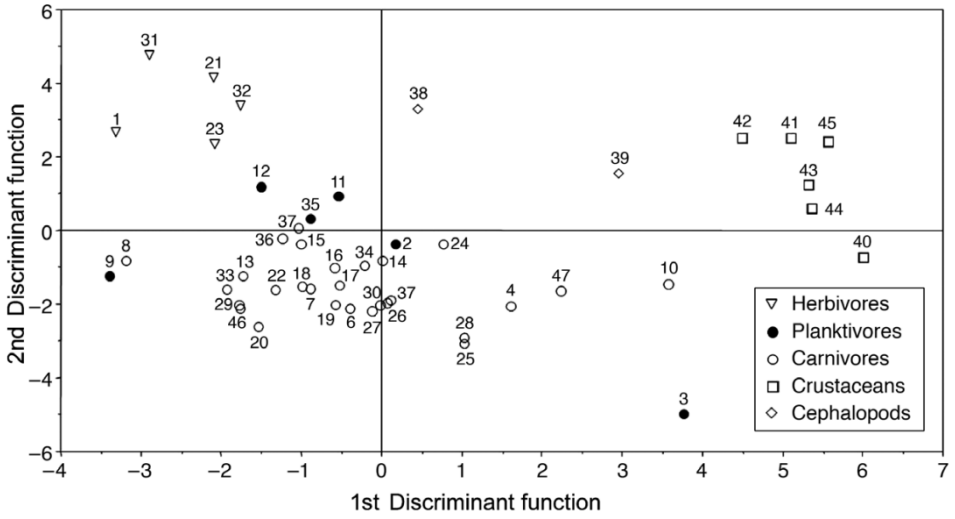


Cahoon et al. 2013
Longenecker 2010
Longenecker et al. 2006

Diet Analysis

- Fatty acid analysis
- 100 prey species distinguished by fatty acid composition
- Captive studies demonstrate relationship of fatty acid signatures and monk seal diet





Piche et al. 2010

Iverson et al. 2010

Successes & Challenges

- Telemetry indicates foraging areas and tracks population connectivity.
- CritterCam shows foraging behavior and prey choice.
- Foraging information combats misperceptions and gains public interest and support.

- Sample sizes low
  - Cost
  - Logistics of capture/handling
- Bias
  - Males – avoid stressing females
  - Adults – limit weight on small animals

Program Goals

Monitor Population Trends

Understand Health Threats and Enhance Survival

Understand Ecology, Behavior, and Requirements

Understand Ecological Relationships and Ecosystem-Scale Processes

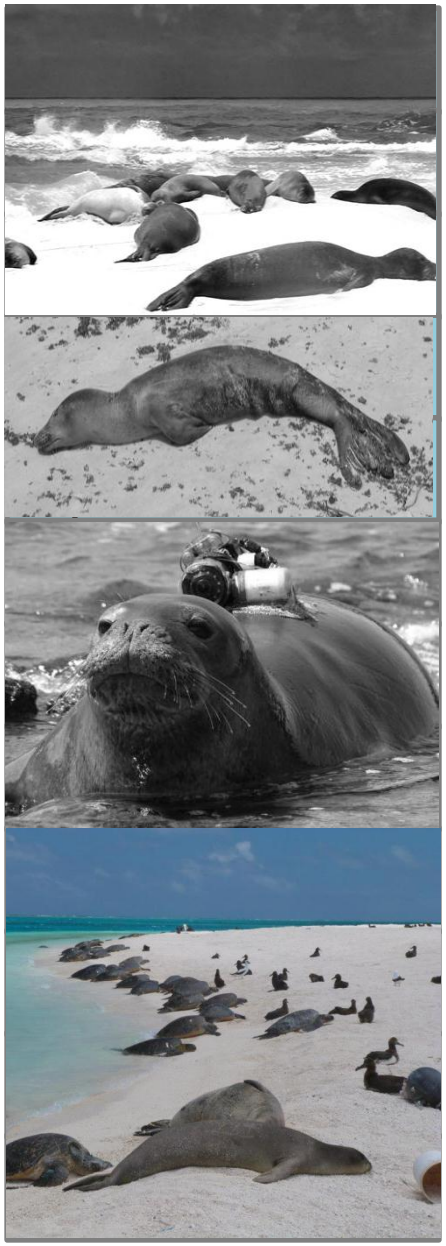
Data Streams

Population Assessment

Health Monitoring

Ecology & Nutrition

Ecosystem Science

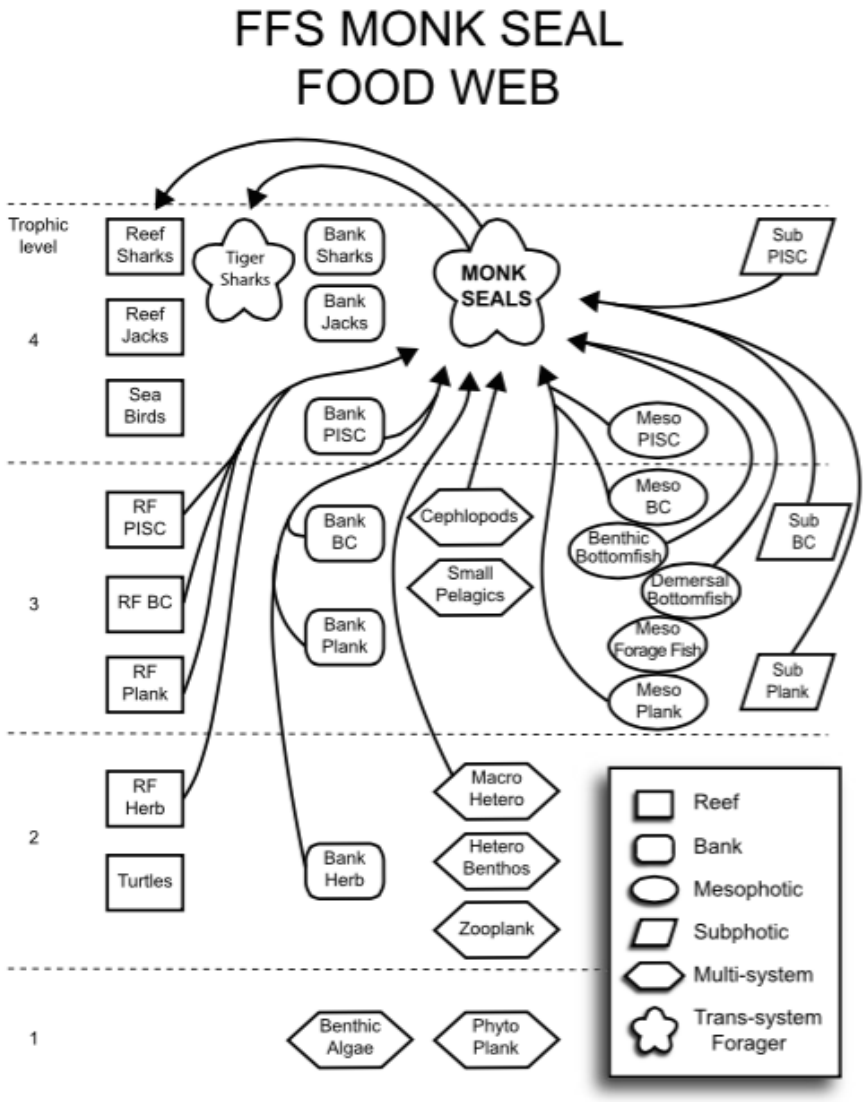


Questions

- Abundance / Trends
- Vital Rates
- Population Structure
- Health/Survival Threats
- Nutritional Needs
- Habitat Use
- Competition/ Coexistence
- Climate Impacts
- Reproduction / Fitness

Ecological Communities

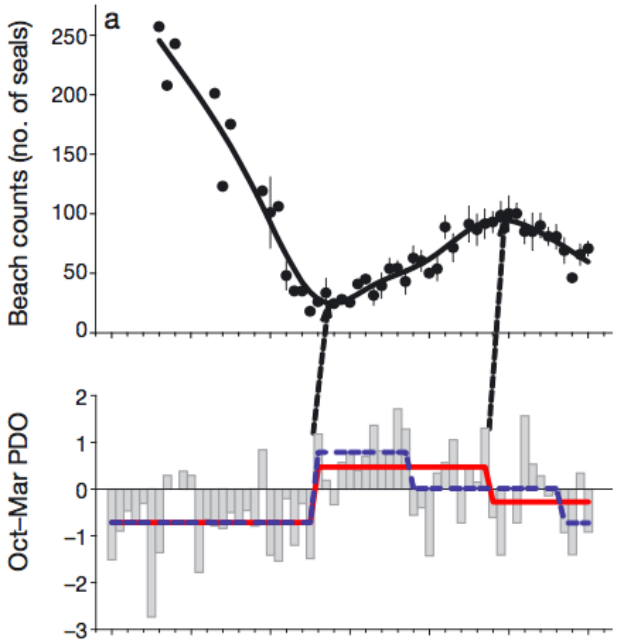
- Ecopath food web model used to discern trophic relationships
- Ecosim model used to simulate future ecosystem scenarios
- Models indicate importance of bottom fish for monk seal carrying capacity
- Models show importance of climate factors as drivers of food web dynamics

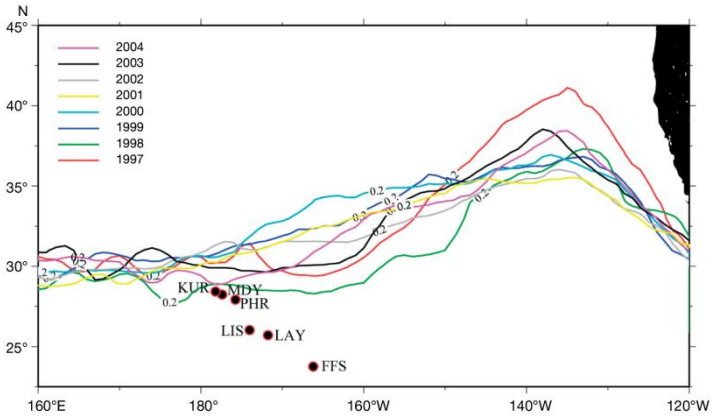


Parrish 2009
Parrish et al. 2012

Oceanography & Climate

- Diverse long-term datasets combined to evaluate system drivers:
  - Monk seal populations
  - Monk seal survival rates
  - Pacific Decadal Oscillation
  - Transition Zone Chlorophyll Front
- Climate factors associated with monk seal population trends
- Ocean productivity related to juvenile survival

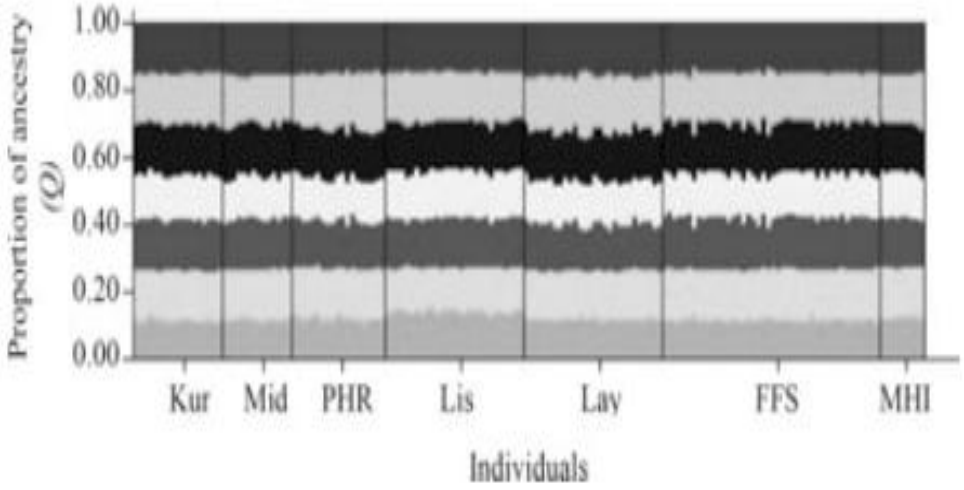




Baker et al. 2006 and 2007 and 2012

Genetics

- 2500+ samples microsatellite genotyped
  - 80 MHC sequencing
  - 50 mtDNA sequencing
- Measures of heterozygosity demonstrate low genetic diversity
- Assignment tests show high connectivity among sites
- Twinning events detected
- Future projects:
  - Parentage assignment analysis
  - Develop new genomic markers



Aldridge et al. 2006
Schultz 2011
Schultz et al. 2009 and 2010 and 2011a/b

Successes & Challenges

- Incorporation of diverse datasets and collaborators to explore complex processes.
- Improved understanding of
  - Ecological relationships
  - Ecosystem drivers
  - Potential climate impacts
  - Micro-evolutionary processes

- Incorporation of diverse datasets requires specialized knowledge and analysis beyond HMSRP capacity.
- Knowledge of ecological relationships and drivers still leaves the challenge of mitigating complex threats.

Up & Coming

- Social science
  - Taking advantage of social media to track monk seal sightings and human interactions with seals
  - Interview-based pilot study provides guidance on gathering seal-fisheries interaction data
- New technology
  - Un-manned areal systems help to survey in-accessible areas
  - Remote cameras provide year-round data where camps aren't possible

MAHALO!